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Light Robotics: a new technology and its applications

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Light can now be used for fabricating, handling, powering and actuating micro-robotics functionalities

Light is an important research tool as it enables us to see things from the macroscopic scale and down to the microscopic scales where our own cells, bacteria and different microorganisms proliferate. A less familiar property of light is that it carries momentum that enables focused light to trap, move and position microscopic objects [1]. This has significant implications as we can now use light to extend our "hands" to reach out and manipulate biological samples with great precision. On top of that, optical forces are non-invasive due to their pico-Newton magnitude and ability to operate through sealed and sterile biological chambers.

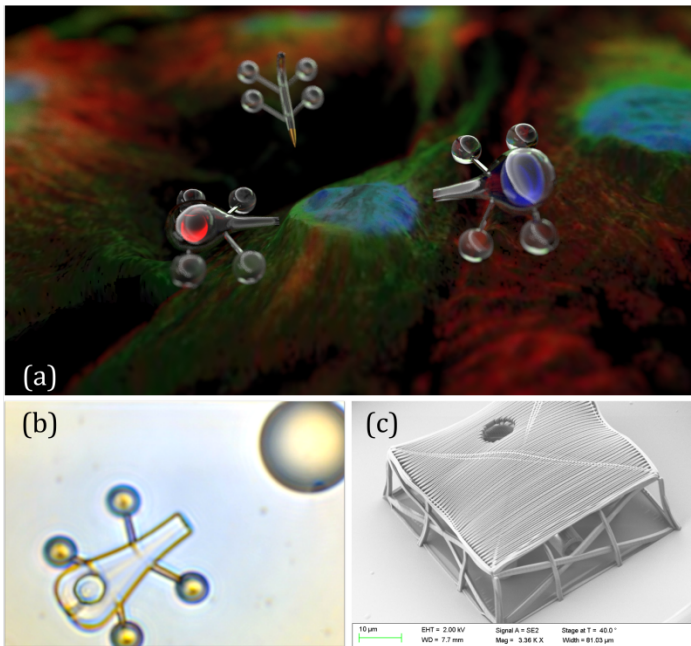


Figure 1. (a) Rendition of a multitude of light-driven micro-robots working together to probe a cell. (b) A hollow micro-robot designed for material transport interacting with an oil droplet. (c) SEM image of the hollow micro-robot. A mask is fabricated on top of the structure to secure exposure of only certain regions by metal vapor deposition.

The latest improvements in optical manipulation and microfabrication can cater to increasingly more sophisticated objects. We leveraged these develop-

ments to create new functional robotic tools for light-based micro-biological experiments. Our light-driven micro-robots are custom-fabricated using a technique known as two-photon polymerization for 3D micro-printing. Focused laser beams are used to solidify a liquid polymer resin with printed feature sizes down to a fraction of the writing wavelength. As with 3D printers, different designs can be made that perfectly suit particular applications. Some of the structures that we have designed and demonstrated include the Wave-guided Optical Waveguides [2] and, more recently, hollow micro-robots for material transport as illustrated in Fig. 1. These recent optical micro-robots utilize light-initiated physical reactions for new functionalities [3-5].

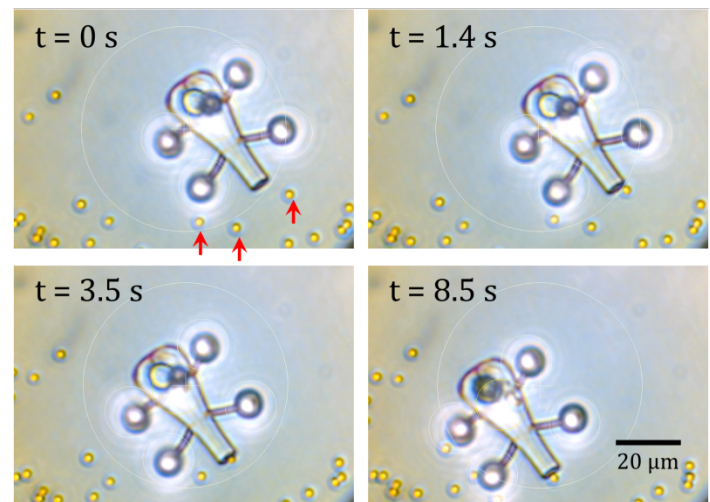


Fig. 2. Syringe-type light robotics. Adapted from ref. 3.

References

1. J. Glückstad, "Optical manipulation: Sculpting the object," *Nature Photonics* Vol. 5, 7 (2011).
2. D. Palima et al., "Wave-guided optical waveguides," *Opt. Express* 20 (3), 2004 (2012).
3. M. J. Villangca et al., "Light-driven micro-tool equipped with a syringe function," *Light Sci. Appl.* 5 (9), Nature Publishing e16148 (2016).
4. D. Palima and J. Glückstad, "Gearing up for optical microrobotics: micromanipulation and actuation of synthetic microstructures by optical forces," *Laser & Photonics Rev.* 7, 478 (2013).
5. J. Glückstad and D. Palima, "Light Robotics - Structure-mediated Nanobiophotonics, Elsevier, Series in Nanophotonics, +400 pages (Q2 2017).